DISSENT AT THE UNIVERSITY OF IOWA: GUSTAVUS DETLEV HINRICHS — CHEMIST AND POLYMATH[1)]

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Abstract. Gustavus Detlef Hinrichs was born in 1836, moved from his province in Denmark (now Germany), where there was a civil war, to the United States. He settled in Davenport, Iowa, in 1861 with his family. He had a long life and his story is replete with both success and failure. He worked from 1863 at the University of Iowa for twenty five years building up a science laboratory with an international reputation. A new university administration slashed his budget in order to concentrate on the 'classics'. The series of disagreements resulting from this action eventually led to Hinrichs' dismissal from the university. His research led him to be amongst those working on a periodic arrangement of the chemical elements like Mendeleev, though his reasoning was somewhat eccentric. He wrote many books and numerous academic papers; he also was amongst the earliest teachers to create physics and chemistry laboratory manuals for his students. He worked in other areas of science apart from chemistry, including astronomy, crystallography, geology and meteorology. He originated the name 'derechos' as a term for wind-damage events caused by straight-line winds. Hinrichs was also was a strong advocate of practical science in schools and universities. He remained active in scientific research until his death in 1923.

Keywords: Gustavus Detlef Hinrichs, University of Iowa, chemical arrangement of chemical elements, physics and chemistry manuals, derechos

Introduction

Gustavus Detlef Hinrichs was born in 1836 and lived to a ripe old age. He wrote extensively with much of his output in German, Danish or French. Some commentators regard him as a crank and others regard him as an eccentric genius fighting for science against a university bent on destroying his work. It is difficult to come to any firm overall conclusions regarding the validity of his scientific reasoning or his scientific competence because he worked across a range of scientific areas and because his theories should be judged within the knowledge base of his times. Some of these issues will become clearer, but much will remain disputed territory. This study attempts to provide some biographical details of his life with a balance of favourable and unfavourable comment about him with the addition of extracts from his own writing. It does appear that his great abilities have been unrecognized by an older generation of historians of science. The classic histories of science omit reference to him entirely, for example, Partington's four volume *History of chemistry* [1] or Gillispie's fifteen volumes *Dictionary of Scientific Biography* [2]. Likewise his name is missing from the common single volume reference commonly available in schools, for example [3-5]. Elliott's biographical dictionary [6], p. 126, is one of the few to mention Hinrichs, but there the entry for him is a modest seven lines. There are some contemporary specialized regional biographies that mention him, for example [7], p. 770. However Hinrichs' achievements appear to be gaining some greater recognition of late, particularly with the wealth of information provided by the internet. This study will provide information, collected from a wide variety of sources, to enable readers to evaluate the career of Gustavus Detlef Hinrichs on its merits.

Hinrichs' Early Years

For the early stage of Hinrichs' long life there are a limited number of sources. Gustavus Detlef Hinrichs was born on 2nd December 1836 [7], p.770, in Lunden, Holstein, Denmark, which later became a part of Germany, the third of six sons. His father, Johann Detlev Hinrichs was a carpenter. His mother, Caroline Catharine Elizabeth Andersen, was the daughter of an artillery captain, Carl Gustav Andersen, an officer in the Danish army.[3)] He went to the local school, where he was an excellent pupil and when only ten years old took an interest in astronomy. In 1850, at the age of thirteen, he ran away from home to support German unrest against the integration of Schleswig into Denmark. He returned home to Lunden in 1853.

There were two wars over the ownership of Schleswig caused by civil unrest by those of German origin in this Danish province with the support of Prussia during the period 1848-1866.[4)]

From 1853 to 1856, Hinrichs was a student at the polytechnic institute; afterwards he studied mathematics, physics and chemistry at Copenhagen University. In his final year he worked as an assistant to biologist Professor Daniel Frederik Eschricht and was greatly involved in research publications,[3)] which included a small book written in 1856 when only twenty years old and several articles [8]. Over his whole career Hinrichs' output was prolific. Whilst in Copenhagen he was a friend and confidante of the children's author Hans Christian Andersen. Andersen was evidently a figure of fun, ridiculed for his gaucherie, but the young Hinrichs appreciated him as a person and as an author. However he was still politically active favouring Holstein (Germany) in the Schleswig-Holstein dispute and was thus unwilling to complete his military service in the Danish army. He married Auguste C. F. Springer (1839-1865) in April 1861[5)] and they left for America in May 1861, probably to avoid conscription to a cause that he did not support. His wife died in 1865 and in 1867 he married her younger sister Anna Catharina Springer (1842-1910). Hinrichs eventually had a total of four children[4)] or three children.[5)] Jeanne Hinrichs names the three children as Gustavus John (first marriage) who became a farmer; Anna (first marriage) who went to university and was a music tutor and writer; and Carl Gustave (second marriage) who studied chemistry wrote two texts and eventually took over his father's laboratory.

On arrival in the USA, the Hinrichs family settled in Davenport, Iowa, on the Missouri River, with Gustavus working at the district school and then Davenport High School as a teacher of modern languages (French and German). In September 1862, Hinrichs took up a position teaching modern languages at the University of Iowa. Planning for the University of Iowa had started in 1847, but it was not open to students until 1855[6)] and in its early years, it was a struggling institution. Benton[7)] (p. 70) explained the recent history of the Faculty stating that '...and the seventh [department], styled the Department of Modern Languages, was created, of which Gustavus Hinrichs, C.P. was elected Professor with a salary of $800'. Benton[7)] (p. 80) continues to detail the positions of staff in the following year and includes 'Gustavus Hinrichs, C.P., Professor of natural philosophy and chemistry'.

Hinrichs was made Professor of physical sciences in the University of Iowa in 1863.[8)] The appointment was unusual in that he did not have a doctorate at that time. Hinrichs is said to have obtained three degrees, all from the USA. Jeanne Hinrichs[5)] (p. 27) states that they were AM from Griswold College in 1870, MD from Missouri Medical College in 1871 and an LLD at Griswold in 1884 whereas Zapffe [8], p. 464, (quoting Sonnedecker, 1953) claims that there was no evidence to confirm the degrees that Hinrichs claimed to possess. Further, in 1897 the College of Pharmacy in St Louis ceased showing his MD replacing it with AM. This calls into question Hinrichs' integrity, on which his credibility rests.

By training, Hinrichs was a mathematical crystallographer [9] and Keyes further grades Hinrichs' research as brilliant. Later he was appointed Professor of Chemistry and Toxicology in the Medical Department, and in 1868 he became chemist to the Geological Survey of the state. Keyes states that [9]:

> [H]e early sought to show that the chemical nature of a substance found visible expression in its crystal form. His especial mission was the mathematical and crystallographic demonstration of the unity of matter, the foundation of which he designated as *Pantogen*.

Keyes is one of those who give great praise to Hinrichs, but not all Hinrichs' colleagues shared this view. For example Gerber[9)] from the English department of the University of Iowa writes 'Despite this success — or, maybe because of it — Hinrichs's arrogance made him no friends on the Iowa faculty.' The Medical Faculty appears to have found him particularly difficult and considered him vindictive and untruthful.[10)] Some of this criticism was no doubt justified and Hinrichs appears to have brought some of his problems on himself. One of the reasons that he was less well known in America than his wide ranging discoveries might warrant is that about two thirds of his publications were in languages other than English. A possible explanation for this is give by Keyes [9] who suggests that Hinrichs was so sensitive and highly strung that he reacted badly to rejection. For example, an article which summarized his views[11)] (p. 312) on *Pangensis* as the basis of the structure of all elements was offered to the editor of the *American Journal of Science*, Professor. J. D. Dana, of Yale University, for publication, was rejected unceremoniously. For some time, he was unable to persuade any other American journal to publish his views, so thereafter he wrote mainly for foreign language journals. He spoke and wrote French, German, Italian and Danish and was familiar with Greek and Latin[12)] (p. 6). Written in French, the same paper was accepted and enthusiastically received in France. Many years later Dana wrote Hinrichs a letter of apology for rejecting his manuscript [9]. However, more than sixty of his articles were published in the *Comptes Rendus* and more than a hundred appeared in the *Moniteur Scientifique* of Paris [9]. Over his lifetime he published nearly fifty books and several hundreds of papers [9]; or three hundred publications including twenty-five books [10]; or a figure of three thousand articles is given by Scerri[13)] [11]. In 1867 he is listed as being chemist to the Iowa Census Board[14)] (p.126), showing that he was prepared to undertake civic responsibilities. He was sometimes asked to give evidence in court, particularly where the evidence related to chloroform or phenacetine.

Hinrichks at the University of Iowa: Wide-ranging activities

The Lavoisier Monument

Hinrichs was the American delegate to the French Academy of Sciences[15)] and a great admirer of the chemist Antoine Lavoisier, so he suggested that a monument to Lavoisier [12] be erected in time for the 1900 French Exposition.[16)] Hinrichs organized the subscription on behalf of American chemists [13,14] listing colleagues in each area who would help collect the subscriptions. The statue was unveiled on 27 July, 1900, in the *Place de la Madeleine*, Paris after more than 100 000 francs had been raised. This indicated his excellent administrative and communications skills and his wide range of contacts in the American chemical community. Unfortunately the statue was destroyed by German troops during the Second World War.

Geology and astronomy

Very early in his career Hinrichs (gave evidence of his interest in astronomy in his articles *The density, rotation and relative age of the planets* and *Introduction to the mathematical principles of the nebular theory, or planetology* [15,16]. The first mentioned article is cited by Brush [17], indicating that Hinrichs' work in astronomy is not entirely forgotten. Eventually some of the ideas that he developed in these papers led indirectly to his ideas on the arrangements of elements in what was later called the periodic table.

In 1875, he was associated with the collection, purchase, description, analysis and distribution of the Amana meteorites to a variety of museums mainly in Europe. In explaining his motivation he wrote [18]:

> [I] felt it my duty to furnish the mineralogical cabinets with good specimens of the meteorites which fell in my neighborhood.

He evidently purchased the specimens from local collectors at $2.00 a pound, partly from his own resources but also with the help of an Iowa businessman. He eschewed profiting from the situation (as he states that others did) and he appears to have behaved very honorably in this matter; he was very efficient in his dealings with thirteen different museums. Later he wrote a book [19] and several other articles about the meteorites. Another area of Hinrichs' geological work was his analyses of Iowa coals on which he wrote a number of articles (such as [20]).

Meteorology

Here he was again an innovator in that in 1875 he started State weather bureau, which was the first state weather service though President Grant had created a National Weather Service in 1870.[17)] The project was very successful initially staffed by volunteers, funded with voluntary donations and operated from the top storey of Hinrichs' house.[18)] Hinrichs coordinated results from up to sixty outlying weather stations staffed by volunteers who had to take readings three times a day and issued regular published reports. The main points of the first quarterly report were enthusiastically reported in the local newspaper.[19] This all made good sense economically in a predominantly agricultural community and the weather service was eventually taken over by the state government with Hinrichs appointed as the first director in 1878 at a salary of $1000 per annum [10]; this was an appointment which he held until he left Iowa in 1889. The wide range of his scientific measurements complemented his other research interests as he recorded earthquake data, magnetic observations, astronomical phenomena solar radiation, sunspot numbers and ozone concentration [10].

The administrative achievement was remarkable, particularly with all his other projects taking place simultaneously, but he is best known for recognising, defining and naming a strong straight-line wind, the 'derecho' that could cause considerable damage in Iowa and elsewhere. Many current articles on US weather recognize his achievement. For example 'In 1888, Iowa weather researcher Gustavus Hinrichs gave widespread convectively induced windstorms the name "derecho" [21]; other similar comments can be found [22,23].

Communication skills and the public understanding of science

It is believed that scientists need to communicate their results to fellow scientists and also to the public at large. Hinrichs' record in this respect is mixed. He communicated well with scientists in Europe and even though he published less material in English than in other languages, his publication record in America was quite considerable on its own. He was a member of the American Association for the Advancement of Science and was in 1915 amongst those with the longest continuous membership [24]. He was still presenting papers[20)] at the American Philosophical Society in 1914 and still writing journal articles in 1922,[11)] the year before his death. His correspondence with British and continental scientists was extensive. On the continent he had a series of correspondents and their portraits and greetings to Hinrichs tend to feature in a number of his books [25], such as J. G. Foschhammer, W. Haidinger, Fr A. Secchi, M. P. E. Berthelot, C. Friedel, P. Schützenberger and C. A. Winkler (see [25]).

In Britain, Charles Darwin and John Tyndall were amongst his correspondents; six letters in which Hinrichs' name occurs are mentioned in Darwin's correspondence[21)] None of these letters are yet available online, but Tydall's summarized comment to Darwin is that Hinrichs is also a correspondent of his and is not 'highly regarded'. This is interesting as in April 1868, Hinrichs had an article [26] on snow flakes published in the *Scientific American* that using Tyndall's experiments on water to support his *pantogen* theory recently published in his book on *Atommechanics* [27]. Perhaps this text did not please Tyndall as it is somewhat speculative. However to ease Darwin's conscience Tyndall agreed to table Hinrichs' papers at the Royal Institution. In his reply to Hinrichs' request to help him publicise his theories, Darwin[22)] politely declines to express a view on Hinrichs' theory but agrees to help publicise them. Hinrichs however appears to accept Darwin's theory of evolution, a stance which does not make him popular with the anti-evolutionary opinions common in the university at the time.

As indicated previously, he planned and collected subscriptions for a Lavoisier memorial worldwide. His efforts for sharing the pieces of the Amana meteorite fragments were brilliantly organized as was his idea of an Iowa weather service. It is difficult to claim that Hinrichs did not communicate, but if communication also involves listening to the views of others, his qualities in this aspect of communication were lacking. He had very definite views on the subject of the Smithsonian Institution with respect of its funding and his view that its administration and Congress had betrayed its charter. Hinrichs believed that the ideal that Joseph Henry (the founder of the institute) had had as a main aim for the Smithsonian 'to increase and diffuse knowledge amongst men throughout the world'[23)] should indeed be the purpose of the Smithsonian. In a lengthy, complex and not terribly clear, open letter to *Science* (the journal of the American Association for the Advancement of Science), he criticizes the way the Smithsonian is run; what might be worth noting is that his concern appears to be the public understanding of science, though he had had disagreements with the secretary, F. W. Clarke, over Clarke's atomic weight determinations, which might be the real purpose of his criticisms.

Jeanne A. Hinrichs[5)] and Adelaide Hinrichs[12)] each tell two stories about Gustavus Hinrichs being right due to his expert knowledge but not having his advice heeded. There had been a series of cold winters in the early 1880s which prevented Iowa farmers obtaining reasonable yields for their apples and destroyed orchards. A local agricultural college advised farmers to plant a variety of apple from a similar latitude in Russia. Hinrichs, after comparing weather data, predicted that the apples from Russia would not be successful and events proved him right. There is a similar set of stories about stone for buildings in Des Moines which he said would be unsuitable and again events proved him right. Evidently he even investigated some possible archaeological sites on his son's land, this time without success. Those are family stories and further evidence would be needed to evaluate their accuracy, but they again illustrate Hinrichs' wide range of interests.

Atom-Mechanics and the Periodic Table

Hinrichs put forward a version of the periodic table which was amazingly good for its time, prior to Mendeléef. Hinrichs had a very unusual set of views about the structure of matter (which he called Urstoff); he had these views as a young man and they stayed virtually unchanged for the whole of his long life. In terms of our present knowledge, the views that he held are simply incorrect, but early on in his career, the views he held yielded some results that were in advance of his contemporaries in terms of modern knowledge, though his reasoning is difficult to follow. His basic idea was that elements are themselves made up of smaller fractions, an idea which was in a sense merely an extension of Prout's hypothesis [28]. However he recognized that the atomic weight of chlorine was 35.5, so he decided that the common building block must a particle that had half the mass of the hydrogen atom and which he called *pantogen*, with an atomic mass of 0.5 or as Hinrichs [29] expressed the concept 'Therefore the atomic weight of pantogen is one half that of hydrogen or one thirty-second that of oxygen'.

Also on page 85 in this 1904 publication [29] Hinrichs defines his meaning of the term 'atomic number'. Even though this is very different from the modern meaning of the term, he was using 'atomic number' to represent a fundamental property of the atom. His definition was '*The atomic number* of any element is the number of pantogen atoms forming one atom of that element'. This will be twice the element's atomic weight. As a gross over-simplification, the modern 'atomic number' will be numerically equal to about half the atomic weight for many elements. It does tend to show Hinrichs ahead of the field again in using new terms. The term 'atomic number' was probably first used by Rutherford (1911)/ Moseley (1914) in the modern sense.

Throughout his life Hinrichs laboured to prove his theory correct; this was an unfortunate philosophical error as many elements were shown to have atomic weights that were neither whole numbers nor divisible by 0.5. In these cases he wrote papers to explain why the element's atomic weight had been inaccurately measured and critiqued the experimenters who produced the 'so-called' erroneous results. This behaviour did not add to his popularity. Examples include [30-32] where J. S. Stas was often the object of his attacks. For example, Hinrichs [33] said under a subheading of 'The greatest false scientist' that 'Our modern chemists under the leadership of Stas have corrupted chemical science by their assumption of a perfection and exactness in experimentation that existed necessarily only in their imagination…' Williams [28] says that Stas' accurate analyses 'provided a firm starting point for the eventual discovery of the periodic system'. Strangely in his earlier years Stas too had believed in Prout's hypothesis but eventually discarded it as a 'pure illusion' on the basis of his experimental results. Hinrichs would have been wise to discard his theory too, but it appears to have become a part of his religious convictions.[3)]

On the other hand Hinrichs did produce perhaps the best periodic table prior to Mendeleev. Firstly he used the results on the spectra produced by Bunsen and Kirchoff in 1859[24)] to form the basis of his table; he was the first to connect the spectra of the elements with their structure. He linked this with his research with differences in the distances of the orbits of the planets (a fact that is now viewed as a chance event). In 1867, as a result of his theories, Hinrichs published a radial periodic chart with each family arranged along spokes of a wheel.[25)] Van Spronsen (1969, pp. 116-124) carefully studied Hinrichs' reasoning and the recognition of Hinrichs as a contender for the priority for the idea of a periodic table should be credited to Van Spronsen [34]. More recently Scerri states that[13)]:

> [A] more eccentric spiral periodic system was created by the Danish-born polymath Gustavus Hinrichs in 1864. Hinrichs was intrigued that atomic spectral frequencies, like planetary distances, show whole number ratios, and he concluded that atomic spectra must therefore be an indication of atomic size.

In his book, Scerri [11], pp. 86-92, has clarified and refurbished the arguments for greater credit being given to Hinrichs' work believing that it is 'rather successful in grouping together many important elements' (p. 91), though he concludes that 'the work of Hinrichs is so idiosyncratic and labyrinthine that a more complete study will be required before anyone can venture to pronounce on its real value' (p. 92). In reviewing Scerri's book, Rouvray [35] does not consider it to be particularly novel but acknowledges that it is well written. It is now the most recent and accessible opinion and further cements Hinrichs' place in history.

Hinrich was certainly vocal in attempting to place his own priority above that of other scientists in the field and was not backward in accusing Lothar Meyer and Mendeleev of using his ideas without acknowledgement.

> [T]here is of course no such thing as a real PERIODIC SYSTEM of elements–consecutive spires of eight elements each increasing the atomic weight by 16 for each spire. This is nothing but a hasty generalisation from my Atommechanic of 1867 on the part of Lothar Meyer. He reviewed my book, condemned it, then published his periodic law. See how Mendelejeff's is only a reflection of mine… . [36].

This book [36] is an unusual text with the first seventy pages being what he called a student atlas; it consists of pictures of famous scientists. The first instructional page (p. 71) defines chemistry and matter historically, and differentiates physical processes and chemical change. But generally it is a somewhat eccentric publication, with the latter part of the text being a justification of Hinrichs' own views. It contains interesting historical material and relates chemistry to the real world, but should not be called *Introduction to general chemistry* as many of the concepts considered are at the cutting edge of research rather than introductory concepts. It is also noticeable that there is considerable duplication of material between his publications with comparatively similar titles. Hinrichs' defense would be that the world of science was not recognizing the truth of his ideas, so it was necessary to repeat them until scientific opinion accepted the truth of his statements. In fact his absolute belief in truth meant that he never compromised. Two brief quotes may give the flavour of his views.

> [T]he supposition that in these days of vaunted enlightenment and general culture, a new scientific truth fully demonstrated by scientific facts needs only to be published to be accepted is contrary to experience which has proved that the scientific authorities today are just as rock-rooted in error and just as prone to denounce and persecute as the most noxious bigots and heretic burners of three and four centuries ago [36], p. 381.

The final words of the book are practically a doxology:

> [E]arnestly have I striven and faithfully have I labored in this vineyard for almost half a century. May the spirit of truth and wisdom accept the work now done. [36], p. 381.

Teaching Science at the University of Iowa

Hinrichs was excellent at teaching science, particularly in his organisation of laboratory practical work where the University of Iowa was recognised as being in the top four American universities in the teaching of science. This is quite an achievement considering how recently the University of Iowa had been founded. Even those who did not favour science recognised the success of his methods:[9)]

> [U]nder Spencer the Preparatory and the Normal curricula remained relatively the same, but emphasis shifted toward the sciences in the Collegiate Department when Gustavus Hinrichs was appointed to teach physics and chemistry. To a certain extent Hinrichs was coasting on the post Civil War enthusiasm for science and its practical applications, but his almost maniacal passion for laboratory teaching -- and for advertising his method – soon made his program known throughout the country.

Wylie [37] claims that Hinrichs was 'a pioneer in developing the laboratory method of teaching science' and the evidence in this portion of the study supports this view. Chemists recognize laboratory experience as being an essential component of any educational program training future chemists. Waite said of Hinrichs [10]:

> [P]rofessor Hinrichs was a "brilliant and gifted educator who pioneered in many fields." According to the Iowa City Press-Citizen (1953) he was the second college professor in the United States to establish a physical laboratory for students in which they could experiment, and it was during his tenure that the University of Iowa was recognized as having one of the four leading science laboratories in North America.

Hinrichs was recognized for his success in physics laboratory work [38]:

> [I]n 1867 Gustavus Hinrichs published papers on "Automechanics" [sic], a few years later received international recognition for his development of student laboratory programs in Physics.

More recently in a School of Chemistry newsletter it was acknowledged that:[26)]

> [O]ne of his [Hinrichs'] many major contributions to building an enduring chemistry foundation at Iowa was to design the first *Chemical Laboratory* and later serving as the first Director of the Laboratory. The 1870 catalog notes that students will "learn more in one day in the laboratory than they could learn in weeks from books"

Jeanne Hinrichs[5)] explained that Hinrichs was eventually teaching science to several hundred students. For example, in 1872, 290 out of 400 University of Iowa students were registered to Hinrichs' courses [10]. He developed new teaching methodologies reliant on laboratory instruction, so he wrote laboratory manuals himself (*The elements of physics* [39]) and (*The elements of chemistry and mineralogy* [40]) as no others were available. These manuals were really different to any other books available at the time. Palmer[27)] [41] believes that these were the first real laboratory manuals and that Hinrichs' innovation was developed further in the early years of the twentieth century for the use of secondary schools. Laboratory manuals are still widely used for chemical instruction today.

The books [39,40] warrant further description. Presumably they defined the experiments that the students actually carried out practically. Hinrichs had two assistants when the course prospered, making it very much like a modern tutorial system. Both books were printed by a local publisher (Griggs, Watson, & Day), presumably motivated by commercial criteria; that is the books had to sell well. Since they were manuals, then generally they were used up by a student writing the results in the book, rather than being sold or passed on to siblings. A student manual is a text in which the student writes his or her own notes and results. It is available for the student during practical sessions and provides the instructions for the practical work and may also contain background information. If the supervisor has written the text, then the verbal instructions will reinforce the written word. When well done, this is a powerful method of instruction. An advertisement shows that the full set of texts would have been ten volumes over four grades (academic years) [42]. There is some doubt as to whether all of these exist as they are advertised as being in preparation and some individual titles are not mentioned in lists of his books[3)] [37] or in the world catalogue or Library of Congress catalogue. The possibility exists that they were written, but bundled into single volumes for each subject as the author of this study has one such volume.

In the physics manual, Chapter 1 is entitled magnitude and weight with subsequent chapters being; mechanical work and machines: molecular properties of matter (with a section on crystallography); light and vision: electricity and magnetism. This was followed by advice to students and teachers and finally a journal of experiments consisting of a few exemplary sets of results and then blank pages. The advice to teachers is excellent [39]:

> [498] The teacher should give his personal attention to each student –– make regular rounds passing from one to the other. He should carefully notice everything the student does –– commend what deserves commendation, and carefully correct errors in handling apparatus, in writing, in calculation, etc. Only if the teacher is thoroughly at home in the work, will he be able to do as required, and instruct with profit. It will be seen, how dif-

ferent this mode of instruction is from the popular “hearing a recitation”.

The overall arrangement of the book is unusual, but sound; it is a little ironic that in 1870 on page 2 he wrote ‘the older systems [fps system etc] are obsolete in science and disappear more and more in common life’; the USA still uses these systems in everyday life. What he wrote about teaching methodology is now accepted as good teaching, but in his era, he was on a lonely path.

The chemistry manual [40], p. 110-111, is also packed with good ideas and practical tips for the teacher. He combines theory, teacher demonstration and student experiment carefully in each chapter as a well integrated learning package. In a section entitled molecular rotation, he uses model-making to simulate rotation and suggested that students cut out cardboard boomerangs and hit them causing rotation and motion in a circle returning to the point of projection. Simple experiments using modeling did not come into general practice for another century.

In considering Hinrichs’ science teaching at the University of Iowa it is clear that Hinrichs really was a gifted teacher, writing up his own practice for the benefit of science teaching. It is unfortunate that many of his ideas were not taken up more generally.

Hinrichs Difficulties at the University of Iowa

Hinrichs early years at the University of Iowa were a spectacular success. He was a good modern language teacher but even better as a teacher of physics or chemistry although there is only limited anecdotal evidence from former students that he was a good teacher.[28)] Hinrichs had the reputation of being a hardworking and competent teacher so students tended to support him in his struggles with the university. His postgraduate students petitioned the university to reinstate him after he was sacked[29)]

> Under Presidents Spencer and Black, Hinrichs’s program in laboratory chemistry and physics had prospered mightily. All students were required to take two years of physical science, Hinrichs was awarded two assistants, and the Regents had provided funds for North Hall, in which the whole first floor was given over to undergraduate laboratories. Hinrichs had even been sent east to inspect the laboratories in several of the finest universities in order to design the best possible facilities for Iowa.[9)]

In 1872 under the new presidency of Thatcher, the situation changed for science and for Hinrichs in the university. Thatcher was a classicist who felt science was not an appropriate subject for university studies. In 1873 Thatcher cut the budget for physics and chemistry severely and reduced the amount of science in the curriculum from studying science over two years to studying science for two terms.[9] The quarrels between Thatcher and Hinrichs were so public and vehement that eventually they were both sacked; Thatcher was dismissed in 1878 on grounds of ill health; Hinrichs was dismissed in 1886[3] on grounds of 'general obstreperousness.'[9] Between 1878 and 1883, Nipher and Springer[30] quote figures to show that Hinrichs, who was appointed chairman of the school of science, again succeeded in increasing the science enrolments. Hinrichs was then removed as chairman, allegedly out of envy, and Professor Leonard was appointed chairman of the school of science. The numbers of students then plummeted disastrously. Various accusations were made against Hinrichs all of which seem trivial in nature and his answers to the accusations would appear to have been reasonable. In the end, the reason for his dismissal is unclear. Perhaps the charge of 'general obstreperousness' is the most accurate that can be found. It is probably true that everyone was tired of Hinrichs' constant complaints and bickering, but the administration and its appointees were generally incompetent and serious questions about their financial probity were raised.

It was assumed that sacking Hinrichs would solve all problems, but Gustavus Detlef Hinrichs was made of sterner stuff. He made sure that the matter received full press coverage with articles condemning his dismissal being written throughout March 1866 as exemplified by; an article entitled 'the University' in *The Marshall Statesman*, an article entitled 'The Hinrichs scandal' in *The Indianola Herald* (4 March, 1886) and an article entitled 'Prof. Hinrichs removed' in *The Iowa City Post* (17 March, 1886). For the next two years he continued to put the university administration under pressure though pamphlets[31] and letters to people of influence such as Professor Schaeffer[32] to investigate the university and its affairs and to reinstate him. Eventually Hinrichs obtained the enquiry which he had wanted so much. This was the Joint Committee appointed by the Twenty-second General Assembly. The results disappointed him. Very briefly, the Joint Committee found that that Hinrichs had made accusations that could not be supported by evidence. One section of the report is particularly apt[33]:

> [T]hat men possessed of so much brains should exercise so little common sense in matters of this kind is almost incredible.

The report was however particularly sympathetic to Hinrichs saying that he was obliging, courteous, kindly, and a real gentleman with the proviso that he had an 'over-sensitive, highly nervous temperament' and that 'he has brooded over his wrongs , until he has been led to say and do things which, under other circumstances , he would not have thought of..'[33] The report actually blamed no one. Instead of having the calming effect desired, this outcome infuriated him; it could be said to be a whitewash, which is precisely what Hinrichs said in his next series of pamphlets.[34,35] Hinrichs stayed in Iowa City from the time of his dismissal from the University of

Iowa in 1886 to 1889 when he obtained a new position (Professor of Chemistry) at the St Louis College of Pharmacy in Missouri; in 1893 he was also appointed to the Chair of Chemistry at the University of St Louis holding both positions. He retired from teaching permanently in 1907. The new position did not silence him with regard to the University of Iowa. The President and Regents were accused of squandering money on incompetent and corrupt employees and of falsifying attendance figures.[36) His verbal attacks on individuals went well beyond the limits of propriety,[34) attacking former colleagues individually for their religion, their moral rottenness, their youthful looks, being divorced and being drunk at work with State University of Iowa Medical Department being targeted in particular. A current web page states[10):

> *GUSTAVUS HINRICHS, Professor of Chemistry: The German-born Hinrichs was a gifted teacher and internationally recognized chemist, but he was also a volatile and sometimes vindictive man. After he was dismissed for being confrontational and abusive, Hinrichs called the hospital a "slaughter house" and claimed that operating surgeons at the clinic had been drunk while attending to patients. The investigating committee found that "the charges originated in jealousy and spite and are without a particle of foundation in fact.*

It would be pleasant to find that the extreme positions taken were reconciled with the passing of time. This unfortunately was not the case. In 1905, some twelve years after his last vicious attacks some old time medical students asked Hinrichs to speak at an alumni gathering in which all living former medical professors were to be invited. Just before the due date Hinrichs' invitation was cancelled causing considerable turmoil.[37)

Society's revenge on Hinrichs appears to have been to forget about him entirely.

Final Days

Gustavus Hinrichs had an excellent relationship with his son who was also a chemist. Gustavus wanted to write a book to explain a system of analysis not dependent on hydrogen sulfide. Such a project would have been very useful if successfully popularized. Thousands of laboratories worldwide would have ceased being subject to the stench of hydrogen sulfide. Carl Gustav, a chemistry instructor in the same department as his father, worked out such a system and they jointly published the book, *First Course in Microchemical Analysis,* though like many of Hinrichs' books it is unusual for the time and contains many illustrations. There are 64 pages of plates including a carefully drawn atlas of microcrystals, 35 pages for the introduction written by Gustavus and 44 pages for Carl's scheme of analysis. It was published through Carl who was the owner of a publishing company, as were a large number of books that Gustavus Hinrichs wrote. This arrangement gave him the freedom from criticism that he desired, but led to considerable repetition of material as they avoided the scrutiny of independent publishers. It would appear unlikely that any of his books were commercially successful as they are quite rare today. In 1907 just after his retirement, he set up a laboratory[3)] with Carl and together they undertook laboratory investigations for the courts and private clients. In 1910 Hinrichs' wife Anna died.[3)] Hinrichs still kept himself busy with research and educational activities. He continued to believe his *pantogen* theory to the end in spite of the fact that with the discovery of the electron and neutron, the composition of atoms was known in greater detail, making the *pantogen* theory untenable. He died on 14 February 1923 at the age of eighty-six [8].

Conclusion

How can Hinrichs' contribution to scientific progress be evaluated? Zapffe, Van Spronsen and Scerri all concentrate on his apparent discoveries in terms of the periodic classification of elements. Whatever the truth about the actual discovery, he was certainly a player in the drama, but in the end the reasons he provided for his classification are not the correct reasons for the construction of the periodic table and he did not use his periodic table to make predictions of new elements. Historians of science tend to see the discovery of the periodic table as an evolutionary event rather than one that should be individually credited. Hinrichs is remembered for being one of those involved in the evolution of the periodic table. However he has other claims to fame. Achievements in geology, meteorology, astronomy and scientific communication are significant, but not world-shaking. To a major extent current appreciation of his achievements are predicated on whether he exemplified the high standards of honesty and truthfulness which he expected of others. Most of his problems with the University of Iowa relate to his perception that they were not honest and truthful. The fact that his qualifications may have been less than he claimed and that independent committees found no truth in many of his allegations, may damage a positive view of his character. *Time Magazine*[6)] when summarizing the early history of the University of Iowa sees its staff as competent and Hinrichs as being cantankerous:

> [I]n spite of its youthful struggles, it [the University of Iowa] was able to collect a strong faculty almost from the start. It was true that the cantankerous Gustavus Hinrichs of Copenhagen, dismissed as head of the School of Science because of his "hasty, angry conduct," caused a major scandal by bombarding the legislature with pamphlets attacking the university (Corruption in the University of Darkest America, Rotten to the Core, Stop That Leak!). But S.U.I. survived.

One feature of his life that seems to be beyond criticism is his ability as a physical science teacher where he left for posterity many well trained students, manuals and courses for his subjects and advances in the teaching methodology of his subject. His teaching should be his memorial.

NOTES

1. Presented at the 2nd Annual Conference of the Bulgarian Society for the Chemistry Education and History and Philosophy of Chemistry, Plovdiv, 25-27 October 2007

2. Dr. William Pitt (Bill) Palmer is a member of the Bulgarian Society for the Chemistry Education and History and Philosophy of Chemistry (CE&HPC), No. 127.

3. Fire, G. (2003). Biographisches-Bibliographisches Kirchenlexicon, (Biographic-bibliographic church encyclopedia), Volume XXII, Columns 531-541, http://translate.google.com/translate?hl=en&sl=de&u=http://www.bautz.de/bbkl/h/hinrichs_g_d.shtml&prev=/search%3Fq%3DUniversity%2Bof%2BIowa%2BGustavus%2BHinrichs%26start%3D10%26hl%3Den%26lr%3D%26sa%3DN (Accessed 09/05/07)

4. Schleswig (2007). http://en.wikipedia.org/wiki/Schleswig (Accessed 10/05/07).

5. Hinrichs, Jeane A. (1946) (#478) Gustavus Detlef Hinrichs (August 6, 1946), an essay available from Archives, Historical Papers Collection of the University of Iowa Library (RG 01.01.03).

6. Anon (1954). The State University of Iowa, *Time Magazine,* Sep 6, 1954. (URL: http://www.time.com/time/magazine/article/0,9171,820113,00.html (Accessed 23/06/07)

7. Benton, T. H. (1867). An address delivered at the annual commencement of the State University of Iowa, June 21st, 1867, Davenport: Gazette Company,Printers.

8. http://famousamericans.net/gustavusdetlefhinrichs/ (Accessed 09/05/07).

9. Gerber, J. C. (1989). English at Iowa in the nineteenth century (Books at Iowa 51 (November 1989) at URL: http://www.lib.uiowa.edu/spec-coll/Bai/gerber.htm, (Accessed 09/05/07).

10. Medical Museum (Accessed 26/05/07) http://www.uihealthcare.com/depts/medmuseum/galleryexhibits/centuryofcaring/collegeofmedicine/03firstfaculty.html

11. Hinrichs, G. D. (1922). *The Pan-American Geologist: A Monthly Journal Devoted to Speculative Geology, Constructive Geological Criticism, and Geological Record*, Volume 38.

12. Hinrichs, Adelaide (1946). (#477) The life of my grandfather (n.d.), an essay available from the University of Iowa Library Archives in Historical Papers collection (RG 01.01.03)

13. Scerri, E.R. Mendeleev's Legacy. *Chemical Heritage Newsmagazine.* Volume 25, No. 1 (2007).

14. Iowa Census Board (1867). *The census of Iowa, as returned in the year 1867 ... Published. under direction of the Census board*. Des Moines: F. W. Palmer, State Printer.

15. Smith, E.F. The Lavoisier Monument. *Science* 5 March 1897, p. 403-404.

16. Anon (2007). The Lavoisier Memorial http://pubs.acs.org/cgibin/abstract.cgi/jacsat/1897/19/i02/fpdf/f_ja02076a013.pdf?sessid=6006l3) (Accessed 05/05/07).

17. Weather Service History (2007) http://www.crh.noaa.gov/dmx/?n=office (Accessed 26/05/07).

18. Saturday Postcard 188 (2007). (Accessed 26/05/07) http://www.rootsweb.com/˜iajohnso/6postcard.htm.

19. Hinrichs, G. D. (1876). Iowa volunteer weather stations, *Daily Iowa State Register,* 26 January.

20. Goodspeed, A. W. The American Philosophical Society [Program details] (Hinrichs' paper was: Determination of the true atomic weight of radium) *Science*, **3** December #39, pp. 833-844

(1914).

21. Darwin's correspondence project (Accessed 15/06/07) http://www.darwinproject.ac.uk/darwin/search/advanced?query=subject:%22%3Cname%3E+Hinrichs%2C+G.+D.%22

22. Darwin, C. Copy of handwritten letter to Gustavus Hinrichs from Charles Darwin. University of Iowa Library Archives in Historical Papers Collection (1868).

23. Hinrichs, G.D. Discussion and correspondence: The Smithsonian Institution and the museum idea, *Science*, 31 August, #24, pp. 273-274 (1906).

24. Palmer, W.P. (2004). Robert Wilhelm Eberhard Bunsen (1811-1899): A Chemist of Distinction, *Proceedings IPSI-2004 International Conference, Mountain Kopaonik, Serbia and Montenegro from April 1 to 4 2004*. Available in refereed proceedings on CD Rom. (ISBN: 86-7466-117-3).

25. Development of the Periodic Chart (2007). (Accessed 31/05/07) http://homepage.mac.com/dtrapp/periodic.f/periodicity.html

26. Anon, (2005). 150 years of University of Iowa chemistry (1855 – 2005): highlights of the early days. (Accessed 23/06/07) http://www.chem.uiowa.edu/news/Newsletters/Newsletter2005.pdf)

27. Palmer, W.P. More Children's Alternative Conceptions of Physical and Chemical Change Obtained from Historical Sources. *2nd International Conference: Research in Didactics of Chemistry, 29 June – 1 July, 2006.* Krakow, Poland.

28. Beilman, J. (1977, November). The University of Iowa oral history project, 1976-1977 (Books at Iowa 27) http://www.lib.uiowa.edu/spec-coll/oralhist/beilman.htm

29. Hinrichs, G. D., Nipher, F. E., Springer, F. & Fellows, S.N. (Various) (1886). Various Reports of the State University of Iowa: An Address to the Alumni; Reprints of Editorials of the Iowa City Post on the Necessity of a Thorough Re-Organization; A Few Facts about the Iowa Weather Service; Statement for Investigating Committee. (Privately bound). This volume includes many pamphlets and reports bound in one volume. References marked with an asterisk (*) can be found in this compilation.

30. Nipher, F.E. & Springer, F. (1886).* An address to the alumni of the State University of Iowa on the present condition of the university. (Privately bound).

31. Hinrichs, G. D. (1888, 30 March). On the Necessity of the Investigation of the State University of Iowa ordered by the 22d General Assembly. (Pamphlet)*

32. Hinrichs, G. D. (1888, 27 February) Letter* to Dr. Chas. Schaeffer, President, State University of Iowa, Why the University is running behind $25,000 a year.

33. Meservey (1889). *Report* of the Joint Committee appointed by the Twenty-second General Assembly to investigate the State University of Iowa*. Des Moines: Geo E Roberts, State Printer. Hinrichs, G. D. (1890a, 27 February) The Iowa Weather Service assaulted by the Iowa University and the Signal Service, because a few beams of light were thrown upon these dark institutions. (Pamphlet)*

34. Hinrichs, G.D. (1890, 27 February) The Iowa Weather Service assaulted by the Iowa University and the Signal Service, because a few beams of light were thrown these dark institutions. (Pamphlet)*

35. Hinrichs, G. D. (1890b, 28 March) Rotten to the core is the management of the State University of Iowa, the whitewash of the Legislative Investigating Committee rubbed off in a few spots. (Pamphlet)*

36. Hinrichs, G. D. (1892, 7 March) Stop that leak!: two of the false statements made officially by the regents of the state university to fool the legislature for one-third of a million dollars more, hush money and boodle. (Pamphlet)*

37. Anon (1905). In Turmoil over Professor Hinrichs, *Iowa City Republican*, 3 May, 1905.

REFERENCES

1. **Partington, J.R.** *A History of Chemistry. In Four Volumes.* Martino Publishing, Mansfield Centre, 1965 (reprinted 1998).

2. **Gillespie, C.C.** *Dictionary of Scientific Biography. In Fifteen Volumes.* Scribner, 1973.

3. **Asimov, I.** *Asimov's Biographical Encyclopedia of Science and Technology.* Doubleday & Co, New York, 1982.

4. **Millar, D., I. Millar, J. Millar, M. Millar.** *Chambers Dictionary of Scientists.* Chambers, Edinburgh, 1990.

5. **Jenkins-Johns, S.** *Random House Webster's Dictionary of Scientists.* Random House, New York, 1997.

6. **Elliott, C.A.** *Biographical Dictionary of American Science: The Seventeenth through the Nineteenth Centuries.* Greenwood Press, Westport, 1979.

7. **Anon.** *History of Johnson County, Iowa, Containing a History of the County, and Its Townships, Cities and Villages from 1836 to 1882. Together with Biographical Sketches.* Iowa City, 1883.

8. **Zapffe, C.A.** Gustavus Hinrichs, Precursor of Mendeleev. *Isis* **60,** 461-476 (1969).

9. **Keyes, C.** The Crystallographic Work of Gustavus Hinrichs. *American Mineralogist* **9**, 5-8 (1924).

10. **Waite, P.J.** The History of Atmospheric Sciences in Iowa. *Proc. Iowa Academy Science* **82**(2), 88-93 (1975).

11. **Scerri, E.R.** *The Periodic Table and Its Significance.* Oxford University Press,New York, 2007.

12. **Williams, W.D.** Gustavus Hinrichs and the Lavoisier Monument. *Bull. Hist. Chem.* **23**, 47-49 (1999).

13. **Beretta, M.** *Imaging a Career in Science: The Iconography of Antoine Laurent Lavoisier.* Science History Publications, Canton, 2001.

14. **Bensaude-Vincent, B.** Between History and Memory: Centennial and Bicentennial Images of Lavoisier. *Isis* **87**, 481-499 (1996).

15. **Hinrichs, G.D.** The Density, Rotation and Relative Age of the Planets. *Amer. J. Sci.* **37**, 36-56 (1864).

16. **Hinrichs, G.D.** Introduction to the Mathematical Principles of the Nebular Theory, or Planetology. *Amer. J. Science & Art* **39**(2), 46 (1865).

17. **Brush, S.G.** *A History of Modern Planetary Physics: Nebulous Earth. Volume 1. The Origin of the Solar System and the Core of the Earth from LaPlace to Jeffreys.* Cambridge University Press, Cambridge, 1996.

18. **Hinrichs, G.D.** The Great Iowa Meteor. *Popular Science Magazine* **7**, 588-596 (1875).

19. **Hinrichs, G.D.** *The Amana Meteorites of Feb. 12, 1875.* St. Louis, 1905.

20. **Hinrichs, G.D.** On the Proximal Analysis of Coals. *Chemical News* September 1868, p. 143.

21. **Bentley, M.L., T.L. Mote.** A Climatology of Derecho-producing Mesoscale Convective Systems in the Central and Eastern United States, 1986-95. Part I: Temporal and Spatial Distribution. *Bull. Amer. Meteor. Soc.* **79**, 2527-2540 (1998).

22. **Duke, J.W., J.A. Rogash.** Multiscale Review of the Development and Early Evolution of the 9 April 1991 Derecho. *Weather Forecasting* **7**, 623-635 (1992).

23. **Bentley, M.L., S.R. Cooper.** The 8 and 9 July 1993 Nebraska Derecho: An Observational Study and Comparison in the Climatology of Related Mesoscale Convective Systems. *Weather Forecasting* **12**, 678-688 (1997).

24. **Howard, L.O.** Which Members of the American Association for the Advancement of Science Have Held the Longest Continuous Membership? *Science* **3**, 791-792 (1915).

25. **Hinrichs, G.D.** *Hinrichs' System of the Chemical Elements, Their Atomic Structure and Genesis.*: Carl Gustav Hinrichs, St Louis, 1906.

26. Hinrichs, G.D. How a Snow Flake is Built, *Scientific American.* April 18, 1868, p. 245.

27. **Hinrichs, G.D.** *Programme der Atomechanik oder die Chemie eine Mechanik der Panatome.* Verein Staaten, N.A., Iowa City, 1867.

28. **Williams, T.I.** *Biographical Dictionary of Scientists*. Harper Collins Publishers, Glasgow, 1994.

29. **Hinrichs, G.D.** *The Proximate Constituents of the Chemical Elements Mechanically Determined for Their Physical and Chemical Properties with 32 Plates*. St Louis: Carl Gustav Hinrichs Publisher, St. Louis, 1904.

30. **Hinrichs, G.D.** Classification and Atomic Weights of the Chemical Elements, With Reference to Stas' Determinations. *Proceedings Amer. Assoc. Adv. Sci.* **18**, 112-124 (1869).

31. **Hinrichs, G.D.** The Atomic Weight of Vanadium Determined from the Laboratory Work of Eighty Years. *Proceedings Amer. Phil. Soc.* **50**, 191-216 (1911).

32. **Hinrichs, G.D.** The True Atomic Weight of Bromine. Proceedings Amer. Phil. Soc. **52**, 543-557 (1913).

33. **Hinrichs, G.D.** The Absolute Atomic Weights of the Chemical Elements Established upon the Analysis of the Chemists of the Nineteenth Century and Demonstrating the Unity of Matter Presented in Simple Language to the General Public. Carl Gustav Hinrichs Publisher, St. Louis, 1901.

34. **Van Spronsen, J.W.** The Periodic System of Chemical Elements: A History of the First Hundred Years. Elsevier, Amsterdam, 1969.

35. **Riuvray, D.** Review of E.R. Scerri's Book on Periodic Table, 2007. *Chemistry World* **4**(5), 68 (2007).

36. **Hinrichs, G.D.** *Introduction to General Chemistry: A Graded Course of One Hundred Lectures with an Atlas of Eight Plates, Representing Chemists, Institutions,*

Crystals, Diagrams and Apparatus: And Illustrations in the Text. Carl Gustav Hinrichs Publisher, St. Louis, 1897.

37.**Wylie, C.C.** Gustavus Detlef Hinrichs. *The Palimpsest* **9**, 183-201 (1930).

38.**Earls, L.T.** Iowa Physics through the Years. *Proceedings Iowa Academy Science* **82**(2), 52-56 (1975).

39.**Henrichs, G.D.** *The Elements of Physics Demonstrated by the Student's Own Experiments with a Plate and a Journal of Experiments in Hinrichs' Elements of Physics Performed in the School Laboratory.* Griggs, Watson & Day, Davenport, 1970.

40.**Hinrichs, G.D.** *The Elements of Chemistry and Mineralogy Demonstrated by Student's Own Experiments with Two Plates and a Journal of Experiments.* Griggs, Watson & Day, Davenport, 1871.

41.**Palmer, W.P.** Children's Alternative Conceptions of Physical and Chemical Change Obtained from Historical Sources Compared with Those Found in Other Recent Studies. *Austr. J. Education Chemistry* **66**, 12-17+23 (2006).

42.**Hinrichs, G.D.** *Hinrichs' Principles of Chemistry and Molecular Mechanics.* Day, Egbert & Fidlar, Davenport, 1874.

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